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ABSTRACT

This document, intended primarily for mortgage lenders, is designed to aid readers in evaluating solar heating technology in the aspects of its capital cost and potential for recovery of investment. Whether or not American consumers will fully exploit this alternative will depend upon interest rates, the allocation of capital to finance the higher initial cost of solar energy devices, and the willingness of lenders to venture into this new technology. Discussed are energy costs as a factor of conventional loan evaluation and life cycle costing. A case study of the latter is included. A program proposal for solar heating loans is described. (MA)

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ENERGY CONSIDERATIONS IN HOME MORTGAGES: AN EVALUATION TECHNIQUE

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Jonathan Gorham
EEEP Director

October 1977
Palmouth, Maine

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- A B S T R A C T -

The present unsettled national energy situation, due in large measure to the unalterable facts of a diminishing fossil fuel supply, threatens to force some decisions on vital sectors of the economy. The possibility of curtailment of conventional fuel supplies, and the related likelihood of rapidly escalating prices in the market for conventional fuels, increases the attractiveness of high-capital-cost sources of renewable energy, particularly solar energy for hot water and space heating.

That wide-spread residential use of solar energy is feasible in the near future had been studied and documented. Whether or not American consumers will fully exploit this alternative will depend substantially on interest rates, the allocation of capital to finance the higher initial cost of solar energy devices, and the willingness of lenders to venture into this new technology. This document, intended primarily for mortgage lenders, is designed to aid readers in evaluating solar heating technology in the aspects of its capital cost and potential for recovery of investment.

¹See in particular "The Economics of Solar Heating," (March, 1977), a study prepared for the Joint Economic Committee of the United States Congress, by researchers and staff of the University of New Mexico.

II. REVIEW OF THE LITERATURE

The literature available for further reading in relevant topics is considerable. Below are some brief descriptions of works used as sources in the preparation of this document. A list of other works of major interest can be found at the end of this section.

(1) The Economics of Solar Home Heating, A Study Prepared for the Use of the Joint Economics Committee, Congress of the United States, March 1977.

This study does a commendable job of comparing the capital cost of solar energy to likely conventional fuel prices, under a series of different energy-market scenarios. The introduction and the first few sections present a good general description of the physical elements of solar technology, performance optimization criteria, and probable costs. Separate feasibility analyses for solar heating are made on a state-by-state basis, with dates of probable future viability for such systems projected for each state under alternate assumptions of fossil fuel price decontrol, and retention of control with concomitant heightened probability of fuel supply curtailment. Finally, policy issues are discussed with recommendations to the Joint Committee for federal action, including mortgage loan guarantees, subsidies, and tax incentives.

The study is a concise report backed by competent analysis and presentation. It is a major piece of source material for anyone needing reference to a general time-frame for development of solar energy as a viable home heating option.

(2) Financing the Solar Home, Undertaking and Improving Mortgage Market Receptivity to Energy Conservation and Housing Innovation, Regional and Urban Planning Implementation, Inc., Cambridge, Mass., June 1976.

Virtually anyone with an interest, professional or otherwise, in the financing of residential solar energy applications should study carefully this thorough, well-written summary of research of actual mortgage market conditions in New England. Herein one finds the results of interviews with a broad range of lenders, government officials and others involved in finance. There is much useful information on a comprehensive array of solar/financial topics such as: constraints on and opportunities for solar financing inherent in the structure of the residential mortgage market; impact of financing realities on the cost of solar heated houses; lender attitudes toward housing innovations and how such attitudes differ by type of lending institution; the prospects for future solar energy financing.

Of particular interest to those who influence lending policy or are influenced by it, the report concludes with a detailed list of suggested options and recommendations for improvements in the mortgage market for solar energy. These recommendations primarily stress the need for federal loan guarantees for solar devices, and the development of a "lender-oriented system certification program" to assist lenders in their economic and performance evaluations of specific devices.

To capsule a lengthy and meticulous report, the authors stress that the lending community is inhibited by two principal problems: the lack of hands-on information about solar technology, and the lack of an adequate supporting policy from the federal government.

(3) The National Bureau of Standards has done extensive work in solar testing and in both technical and economic evaluation. Major documents of interest are:

(a) NBSIR 75-712 Solar Heating and Cooling in Buildings: Methods of Economic Evaluation. This is a detailed overview of Life Cycle Costing methodology in readable form (with examples), with both a rationale of the technique and a discussion of economic uncertainties. Includes bibliography.

(b) NBSIR 76-1127 Evaluating Incentives for Solar Heating. This document analyzes the impact of, and makes recommendations for, effective federal incentives for solar energy use. It measures the impact of incentives on the real cost of solar energy through the use of a computer simulation model. Included is a simple Life Cycle Cost computer program (in BASIC), as well as a bibliography.

(c) NBS BSS-64 Retrofitting Existing Housing for Energy Conservation: An Economic Analysis. Although primarily intended for retrofit applications to existing houses of such energy conserving devices as insulation and weather-stripping, this detailed study applies equally well to solar heat retrofit situations. Using familiar concepts from microeconomics, a given installation can be measured and sized by comparing marginal savings to marginal cost. By the same method, optimum investment schedules under fixed budgets can be determined. A methodology for marginal heat load calculation is given, along with suggestions for computing the present values of future energy costs.

(d) NBSLD The Computer Program for Heating and Cooling Loads in Buildings. This highly technical computer program for estimating heating and cooling loads deserves the careful study of an experienced programmer.

NBS has used the program successfully in its own testing procedures; it was developed primarily for "in-house" use. The text is complete with technical narrative, a sample listing of the program, and a sample run.

(4) The New Residence 1977: Solar Design Workshops, sponsored by the Office of Continuing Education and Public Service, University of Illinois at Champaign-Urbana.

Replete with technical data, this study presents an excellent review of solar equipment design and operation thereof including: the importance of energy conservation in buildings; operating principles of, and materials in, solar collectors; performance criteria; controls; legal questions; methods of economic evaluation; and marketing of solar components. A case study of a solar heated house is included. This report is highly recommended as a comprehensive introduction to a serious study of solar energy.

Recommended for further reading:

(5) Engineering Economy: Analysis of Capital Expenditures, 2nd edition, Gerald W. Smith, The Iowa University Press, Ames, Iowa, 1973.

(6) IF Systems Construction Analysis Research, Volume 7, Number 2-3. University of Montreal, 1976. (Another technical packet similar to the University of Illinois study mentioned above.)

(7) Installation and Maintenance of Solar Heating Systems, Solar Energetics and Institute of Energy Conversion, University of Delaware, March 1976.

(8) National Bureau of Standards publications:

- NBSIR 76-1137 Thermal Data Requirements and Performance Evalua-

tion Procedures for the National Solar Heating
and Cooling Demonstration Program

- NBSIR 76-1187 Interim Performance: Criteria for Solar Heating
and Cooling Systems in Commercial Buildings

It is recommended that anyone referencing work done by NBS request a complete list of NBS publications from NTIS, U.S. Dept. of Commerce, 5285 Port Royal Road, Springfield, VA 22151, or from the Superintendent of Documents, Government Printing Office, Washington, DC 20402.

III. ENERGY COSTS AS A FACTOR OF CONVENTIONAL LOAN EVALUATION

The "PITI ratio" (together with other tests of applicant eligibility) is widely used today in mortgage loan decisions as a lender's "rule of thumb".² If the sum of Principle, Interest, Taxes and Insurance (PITI) payments that an applicant will have to carry in any month exceeds 25% of his monthly income, then the likelihood of approval is substantially diminished. Those loan applicants who have minimized their initial costs, therefore, will have a distinct advantage when this PITI ratio is applied in a lending decision.

As pointed out in the introduction there is some question as to whether a lending guideline can survive as a reliable indicator of lending risk if it does not recognize utility costs as a factor influencing mortgage eligibility. If these costs are mainly responsible for the steadily increasing cost of maintaining a house, they should be included in any meaningful cost-to-income formula for determining mortgage eligibility. Replacing the current PITI ratio with a PITI + E ratio would make the inclusion explicit. The advantages of including energy costs in the PITI ratio (and concurrently increasing the 'allowable threshold' 5-10 percentage points would be:

- (1) an increase in the relative eligibility of high capital/low operating cost houses, by replacing some monthly operating cost with some monthly capital cost, and narrowing the difference in risk; and
- (2) the creating of a mechanism for making risk estimation automatically sensitive to rapidly changing energy costs.

²For more on this and other topics relating to lenders and solar energy, see the thorough and important work "Financing the Solar Home", by RUPI, Inc. (see Footnote 1).

Note that, over the short run, there is no threat to the eligibility of buyers of conventionally-equipped houses for two reasons: (1) since the market penetration of alternate energy devices is only beginning, the number of buyers is still relatively small, and (2) the prices of conventional fuels are still 'low' relative to their projected levels in future years. Over the long run, however, given a finite aggregate supply of loan capital and a consistent rise in the prices of conventional fuels, use of the modified ratio would tend to set such buyers at an increasing disadvantage. How far the 'allowable threshold' for this ratio should optimally be increased for a long-term mortgage is a matter for individual assessment, related strongly to the problem of energy cost estimation featured in the Life Cycle Costing technique. That energy costs are likely to change over a mortgage life is also a consideration that will influence the weight assigned to the added E factor.

A Note on Durability and Performance of Alternate Energy
System Components as a Part of Lender Risk

Whether or not specific components measure up to acceptable standards is a question that must be investigated on an individual basis in many cases. Unfortunately, at present there are no simple methods for accomplishing this task. Individual banks may have to acquaint themselves with whatever components are commercially available and to determine their own standards until performance criteria for lending decisions become established. In addition, specific components might be compared to the minimum specifications already compiled by the National Bureau of Standards. The NBS has done extensive work in the testing and evaluating of

materials and designs commonly found in solar equipment.³ The NBS is undertaking one of the largest efforts of solar performance evaluation, but private foundations and corporations are conducting similar research, and their results should not be overlooked.

³See in particular NBS publications NBSIR 76-1137 ("Thermal Data Requirements and Performance Evaluation Procedures for the National Solar Heating and Cooling Demonstration Program") and NBSIR 76-1187 ("Interim Performance Criteria for Solar Heating and Cooling Systems in Commercial Buildings").

IV. LIFE CYCLE COSTING

A. Introduction

The American consumer has been conditioned to a cyclical pattern of waste and inefficient consumption through long experience with low energy prices (the result of inherent fuel market inefficiencies and government intervention). Because the cost of fuel for home heating systems was so low, the cost of installing the heating equipment came to be measured against the benefits of convenience of operation. Eventually the design, installation and maintenance of home heating systems became the prerogative of fuel distributors. The consumer's "role" in heating his house narrowed quickly to that of paying the fuel bill regularly; the unfortunate result has been consumer disinterest in the design and function of his source of home heat and consequently in its efficiency and in whatever alternatives might be available.

Solar technology for the heating of interior space and hot water has only recently entered the field of energy options open to large segments of the home-buying public. At present, the state of the technology is characterized by relatively little experience and an imperfect knowledge of such basic elements as performance, reliability and cost. Despite significant progress in identifying the advantages and disadvantages of solar technology in general (and the design of specific components in particular), it is unlikely that our economy will determine rapidly a market price for solar technology that reflects its real value. There is a vital need for the information and research necessary to make this kind of market adjustment.

Meanwhile, the selection and application of solar devices in their present state of development must be based on a series of well-defined "interim indicators of value", which will have to be used in place of more specific market data. This paper is intended to describe the major obstacles to an adequate evaluation of solar technology, and to suggest methods of finding appropriate "interim indicators" by which investments in alternate energies might be compared with those in conventional systems.

Any method of cost evaluation which attempts to compare the economic merits of solar heating with those of conventional heating necessarily involves uncertainties on both sides. In the case of solar heating, these arise because it is a "new" technology; in the case of conventional heating they occur because no one can predict the future availability and price of fossil fuels. We need to establish a set of assumptions which we can use in place of uncertainties and/or unavailable data.

The assumptions used to replace unavailable data must be chosen with extreme care. No matter what method we use, a fundamental uncertainty will always exist in attempting to estimate the impact of future economic developments on such vital and interconnected factors as property values and real disposable income. Existing lending guidelines will be affected by changing economic conditions. As fossil fuel becomes more expensive, the cost of owning a house equipped with a conventional heating system will rise in proportion, affecting both the owner's ability to pay on his mortgage and the likely market value of his property. The lender's risk factor on this mortgage will have to rise to reflect these market changes, and may, in time, equal or exceed the risk factor now associated with solar heated homes.

In other words, the real challenge is not merely to produce sets of figures for comparison, as much as to make some sense of an unknown future

for which we very likely have no precedents. Once this task is done, the figures come easily.

B. Volume Loan Evaluation: Problem and Solution

Life Cycle Costing analysis can be made as detailed as circumstances require and as tedious as time permits. The costs of owning a house (or any durable piece of equipment) over a long period of time will be highly sensitive to any unique characteristics that the installation may have, such as site location, architectural design features, etc. The long-run costs of owning older buildings, for example, will vary according to the age of the structure, the history of its upkeep, the use to which it is put, etc. For Life Cycle Costing to be a useful tool of economic evaluation, therefore, separate analyses must be run on each financing proposal under consideration. This requirement could consume large amounts of time and effort if some means of streamlining the computation procedure cannot be found.

One such means might be the development of a widely-accessible computer program which could rapidly perform the routine calculations involved in Life Cycle Costing for houses of all sizes and designs. The two parts of this program are, necessarily, (1) heat load calculation, and (2) cost analysis.

(1) Heat Load Calculation -- If heat load is not already known, the program must accurately determine the heating requirement of any particular design. Since heat 'load' is exactly the same as the amount of heat escaping a structure through its windows, doors, walls, floor, and roof, this calculation depends on: (a) the number of degree days relevant to the site location, (b) the size of the building's various components, and (c) the thermal resistance of each component to heat flow. The first and second of these values will have to be part of data input; the last may be treated similarly or retrieved from a larger data base in permanent storage (thermal resistance

values of a huge variety of building components have already been compiled and standardized by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). This section of the program can and should be made quite sophisticated, evaluating not only 'structural heat loss' but 'internal heat gains' from such sources of heat as electric appliances, human occupants, and passive solar radiation.

(2) Cost Analysis -- Having determined the required output of the heating system in the building under consideration, the program should then compare output to costs of several alternative heating systems. With acquisition and servicing cost data of each system as input*, the program can then perform Life Cycle Cost calculations of each alternative, applying the appropriate present value formulas.*

The advantages in time-efficiency of the use of computers will make possible rapid and routine comparisons of the value of different heating systems relative to a given set of assumptions regarding future energy prices. A computer program, however, no matter how sophisticated, is powerless to reduce the need for making some assumptions; it should be re-emphasized that any 'indicators of value' produced by the Life Cycle Costing technique will be functions of the long-term assumptions made at the outset of the process.

* See section IV-C

C. Methodology of Life Cycle Costing

1. Elements and Assumptions

Rapidly escalating fossil fuel prices make alternative energy sources in general, attractive and make selected systems in particular, economically viable. Their potential for reducing long-range energy costs provides the impetus for their development, so their value must first be estimated by studying their impact on private energy expenditures. Accordingly, positive energy cost savings would represent a positive factor of the value of a proposed system, and a negative factor otherwise.⁴

Two or more different heating systems can be compared by calculating the net present value of total costs associated with the acquisition, operation, maintenance and other financial servicing of each system over its useful life. The elements involved in measuring the cost efficiency of any system include:

(a) Heat load calculation -- The heating requirements for any system are a function of the structure and insulation of the building to be heated, and will be the same regardless of type of system. Heat requirements are generally known from past experience or from comparison to buildings of similar type. However, sometimes accurate estimation will require lengthy calculation (particularly in the case of new construction of unconventional design), and in such cases, heat load estimates should be procured by the homeowner.

⁴At the outset, we assume that the performance of the proposed alternate system is equal to that of the conventional system it would replace. Risk factors relating to the performance and durability of alternate systems are discussed in a later section.

(b) Cost of acquisition -- The cost of buying, transporting and installing each system under comparison (including the cost of any building modifications) must be estimated. The cost of an installed system can be readily investigated and involves little guesswork.

(c) Cost of maintenance -- Annual maintenance expenditures, including costs of inspection, parts and labor, should be expressed as a percentage of initial acquisition cost. If estimated, they should conform to the manufacturer's recommended schedule of maintenance. Major system alteration or 'capital' repair expenditures should not be included if they occur within the estimated useful life of the equipment.

(d) Cost of insurance -- Percentage of acquisition cost, per year.

(e) Taxes -- An estimate, based on assessed value, should be expressed as a percentage of acquisition cost.⁵

(f) Energy costs -- Of all the estimates to be made in the process of Life Cycle Costing, this is one of the most uncertain. For the life cycle comparison to work, some assumption must be made about the likely future behavior of energy prices. The difficulty is the same as that of applying short-run analysis to a long-run problem, and will be the main reason why application of Life Cycle Costing techniques by different people will yield varying estimates of value. A given system may be determined to be "economic" if alternative fuel prices rise 10% or more over the life of the system and "uneconomic" under an assumption of lesser price increases. In fact, if other parameters (a-e, above) are held con-

⁵ (The income tax effects of tax deductible interest payments on high-capital-cost heating systems will marginally influence the comparison, but are disregarded here as an unnecessarily complicating factor.)

stant, the cost efficiency of a proposed alternate heating system might be expressed as a "breakeven rate" of conventional fuel price increase, being a positive indicator to the extent that the breakeven rate is a reasonable expectation on long-term events in the conventional fuel market. (Involving sensitivity analysis, the process is somewhat complicated.⁶⁾

(g) Discount rate -- The discount rate is defined as the rate available on the next most attractive investment, and may be determined from available market data. Again, differences from yields of U.S. Government 3-5 year securities in the period 1952-1970.) In general, the higher the assumed discount rate is, the less attractive a high initial investment will be.

(h) Rate of Inflation -- The rate of inflation affects and is closely related to both energy costs and the discount rate. Note that energy costs and the discount rate can both be expressed in nominal terms (with inflation kept as a separate factor) or real terms (with inflation pre-accounted for). In either case, all figures must be consistent, and computation is probably easier when real terms are used.

(i) Period of Analysis -- Should conform to manufacturer's guarantees of the useful life of any system.

2. Formulas⁸

Variables:

A = acquisition cost

A₀ = assessed value

m = annual maintenance cost (% of A)

⁶See National Bureau of Standards publication No. NBSIR 75-712: Solar Heating and Cooling in Buildings: Methods of Economic Evaluation (July, 1975)

⁷Stephen Petersen. See NBS publication NBS BSS-64: Retrofitting Existing Housing for Energy Conservation: An Economic Analysis.

i = annual insurance cost (% of A)

t = annual property tax (% of A_0)

Q_0 = annual input of primary fuel (converted to standard units from the calculated heat load)

Q_1 = annual input of auxiliary fuel, in standard units

P_0 = current price per unit of primary fuel

P_1 = current price per unit of auxiliary fuel

ΔP = expected long-term annual rate of conventional fuel price increase, assumed here to apply to both primary and auxiliary fuel

I = expected long-term annual rate of inflation

D = discount rate

L = years of useful life of system

$D' = D$ expressed in real terms: $(D/I)-1$

$\Delta P' = \Delta P$ expressed in real terms: $(\Delta P/I)-1$

The Life Cycle Cost of a given heating system is the sum of the following:

(a) the cost of acquisition, A

(b) the present value of insurance and maintenance:

$$PV_{IM} = (i + m) \times A \times (1 - (1 + D')^{-L}) / (D')$$

(c) the present value of taxes:

$$PV_T = (t) \times A_0 \times (1 - (1 + D')^{-L}) / (D')$$

^BThis section draws heavily on: (a) NBS publications NBSIR 75-712 and NBS BSS-64 (see footnote 5), and (b) "Installation and Maintenance of Solar Heating Systems," Solar Energetics and Institute of Energy Conversion, 1976. See also Gerald W. Smith, "Engineering Economy: Analysis of Capital Expenditures"

(d) the present value of primary fuel input:

$$\begin{aligned} PV_{Q_0} &= \sum_{n=1}^L \left(\frac{1+P'}{1+D'} \right)^n \times (Q_0 \times P_0) \\ &= \frac{1+P'}{D'-P'} \cdot \left(1 - \left(\frac{1+P'}{1+D'} \right)^L \right) \times (Q_0 \times P_0), \quad D' \neq P' \\ &= L \times (Q_0 \times P_0), \quad D' = P' \end{aligned}$$

(e) the present value of auxiliary input:

$$\begin{aligned} PV_{Q_1} &= \frac{1+P'}{D'-P'} \cdot \left(1 - \left(\frac{1+P'}{1+D'} \right)^L \right) \times (Q_1 \times P_1), \quad D' \neq P' \\ &= L \times (Q_1 \times P_1), \quad D' = P' \end{aligned}$$

or, Total Life Cycle Cost is:

$$A + PV_{IM} + PV_T + PV_{Q_0} + PV_{Q_1}$$

This method can be applied to two or more different heating technologies of different fuel types, and the results compared. That system has inherently greater value which sums to the lowest Life Cycle Cost.

C. A Case Study: Gilsland Farm

The Gilsland Farm Building in Falmouth was built by the Maine Audubon Society to house its main offices. It features a prototype solar and wood heating system designed by engineers at the University of Maine. The components of the system are not commercially available, nor have they been reproduced. This and other characteristics make it difficult to compare this building to other solar heated buildings; however, it is felt that a discussion of costing method on an existing building is preferable to a discussion of a necessarily arbitrary hypothetical model. The Life Cycle Cost evaluation that follows compares the cost efficiency of Gilsland's installed plant with that of: (1) and equivalent oil-fired system, and (2) and equivalent electric baseboard system, over 30 years useful life.

Elements and Assumptions: Gilsland Farm

- | | |
|---|----------------------------|
| (1) Heat Load for the 1976-1977 heating season | 126,410,140 BTU* |
| (* equivalent to 1290 gallons of no. 2 heating fuel, or 37,027 KWH) | |
| (2) Cost of Acquisition | A = \$61,424 |
| (3) Cost of Maintenance (annual) | m = 0.5% |
| (4) Cost of Insurance | i = 0.4% |
| (5) Taxes ⁹ | t = 2.1% |
| (6) Electric Input for Solar Collector
(assumed annual average) | $Q_o = 10,000 \text{ KWH}$ |
| (7) Wood Input for Furnace
(assumed annual average) | $Q_1 = 3 \text{ cords}$ |

⁹As a non-profit organization, Audubon pays no property tax. Assessed value is assumed here to be equal to acquisition cost.

Major Assumptions:

(h) Energy costs

Cost per KWH of electric input..... $P_0 = \$0.0335$
 Cost per cord of wood..... $P_1 = \$40.00$
 Assumed nominal rate of fuel price
 increase (annual)..... $\Delta F_0 = 10\%$

(i) Inflation (annual rate)..... $I = 6\%$

(j) Discount rate..... $D = 9\%$

(k) The capital cost of the equivalent

conventional systems is assumed for:

(1) oil-fired forced hot air:..... $A = \$8000.00$

(2) electric baseboard:..... $A = \$2000.00$

(l) Current conventional fuel prices

(1) oil-fired forced hot air:..... $P_2 = \$0.46/\text{gallon}$

(2) electric baseboard:..... $P_3 = \$0.0335/\text{KWH}$

Computation:

$$D' = (1.09/1.06) - 1 = 0.0283$$

$$P' = (1.1/1.06) - 1 = 0.0377$$

Present Value of Tax, Insurance, and Maintenance Expenditures over 30 years:

$$(0.021 + 0.004 + 0.005) \times 61,424 \times (1 - (1 + 0.0283)^{-30}) / (0.0283) = \$36,924.$$

Present Value of Total Expenditures for Electric Input, 30 years:

$$\left(\frac{1 + 0.0377}{0.0283 - 0.0377} \right) \left(1 - \frac{1 + 0.0377}{1 + 0.0283} \right)^{30} (10000 \times 0.0335) = \$11,608.$$

Present Value of Total Expenditures for Wood Input, 30 years:

$$(1/0.0283) (1 - (1/(1 + 0.0283))^{30}) (3 \times 40) = \$2404.$$

Total:

$$\$36,924. + \$11,608. + \$2,404. + \$61,424. = \underline{\underline{\$112,360.}}$$

¹⁰ The annual rise in the cost of wood is assumed to be equal to an annual rate of inflation of 6%; hence rate of real price increase is zero.

Life Cycle Cost of an oil-fired forced hot air system for the same building:

This system would burn 1,290 gallons of fuel oil and 1880 KWH (in the furnace blower fan) annually. The average annual maintenance expenditures are assumed to be 1.0% of acquisition cost.

Present Value of Tax, Insurance, and Maintenance Expenditures over 30 years:

$$(0.021 + 0.004 + 0.01) \times 8,000 \times (1 - (1 + 0.0283)^{-30}) / (0.0283) = \$5,610.$$

Present Value of Total Expenditures for Electric Input, 30 years:

$$((1 + 0.0377) / (0.0283 - 0.0377)) (1 - [(1 + 0.0377) / (1 + 0.0283)]^{30}) (1,880 \times 0.0335) = \$2,182.$$

Present Value of Total Expenditures for Oil, 30 years:

$$((1 + 0.0377) / (0.0283 - 0.0377)) (1 - ((1 + 0.0377) / (1 + 0.0283))^{30}) (1,290 \times .46) = \$20,562.$$

Total:

$$\$5,610. + \$2,182. + \$20,562. + \$8,000. = \$36,354.$$

Life Cycle Cost of an electric baseboard heating system for the same building:

This system would require 37,027 KWH for operation, annually. maintenance is assumed zero.

Present Value of Total Tax and Insurance Expenditures over 30 years:

$$(0.021 + 0.004) \times 2,000 \times (1 - (1 + 0.0283)^{-30}) / (0.0283) = \$1002.$$

Present Value of Total Expenditure on Electric Input, 30 years:

$$((1 + 0.0377) / (0.0283 - 0.0377)) (1 - ((1 + 0.0377) / (1 + 0.0283))^{30}) (37,027 \times 0.0335) = \$42,982.$$

Total:

$$\$1002. + \$42,982. + \$2,000. = \$45,984.$$

The indication of value of Gilsland's installed heating system, as far as private costs are concerned, is negative, given the long-term assumptions used. Changes in the assumptions will yield changes in the results.

Audubon has discovered that structural flaws causing leakages in the system were such that actual performance last season was below design performance. The sources of the leaks are being investigated and repaired as they are found. Output of the system should be substantially improved by next heating season; meanwhile, the foregoing analysis reflects actual performance this past season. It is included here for purposes of demonstration only, and should not be considered indicative of actual system cost efficiency, which will improve as repair work continues.

V. SOLAR LOANS: PROGRAM PROPOSAL

In the absence of a well-developed solar energy industry, further development of the market in the near future rests in the hands of those who are willing to experiment to some degree on their own. We feel that there is a large role for the lending community to play here. We would like to suggest, in broad outline, a pilot loan program which might be undertaken by concerned bankers to investigate the real-market conditions and potentials of solar energy. While some positive first steps have been taken by individual banks, there does not appear to be any overall acceptance by the banking industry that this new technology should be aggressively supported. In general, bankers recognize the implications of the advent of solar energy including:

- 1) the reality of a finite supply of fossil fuels regardless of the time frame,
- 2) the economic impact of the OPEC nations' control of petroleum,
- 3) the undeniable escalation of costs, with particular reference within the context of this paper, upon the housing industry, and
- 4) the necessity of a National Energy Policy.

For quite legitimate and understandable reasons, individual bankers and banks are reluctant to take unilateral steps to extend more than token credit to would-be borrowers for the purpose of investing in solar hardware. Major reasons are:

- 1) the relatively unproven "state of the art" in the market place, both as to product reliability and long-term economic benefits,
- 2) an uncertainty about the true effect of solarization upon collateral value,

3) historic conservatism with respect to putting depositor's dollars at risk in a relatively exotic field.

On the other side of the coin, the banking industry should have several compelling incentives to take an aggressive stand in the solar field given an admitted understanding of the overall problem of energy and the need for energy conservation. As providers of funds, bankers occupy a strategic niche in this country's economic fabric. Bankers have a vested self interest at two levels: 1) to support National Policy in broad outline, utilizing the powerful forces of the private sector as opposed to potential domination by the federal government, and 2) to stimulate and promote the financial health of their own customers from manufacturers to retail consumers. Depending on the size of the institution, bankers have a unique opportunity to influence legislative concepts with respect to the encouragement of alternative sources of energy. The industry should be aware of the implications of price decontrol of fossil fuels, the elements of subsidy at federal and state levels, and such matters of local concern as building codes.

At the practical level, the regional or local banker is simply not in a position to develop total expertise in the field of solar energy. This is a broad spectrum of technology which requires the input of the federal government through such agencies as HUD, FmHA, NBS, ERDA, as well as that of industry with extensive research and development capacity, and that of small innovators, architects and engineers with solar orientations. This being the situation as we view it, banker support should be specifically directed at solar hot water heater retrofit installations (new construction may be included as long as the lending arrangements for the heater can be kept separate from the principal mortgage.) Solar hot water heaters are more widely available on the commercial market, and require a lower capital

investment than do active solar space heating systems. Their smaller size and their availability in kit form reduce the need for extensive consumer pre-education in installation, operation and maintenance, and will require minimal alterations of the buyer's home. The lower capital cost of such systems is more appropriate to a short duration loan experiment of the type proposed, requiring less of a bank's "venture capital" fund. For consumers, operating savings will be simpler to quantify month after month, making the cost savings of solar energy more visible, sooner. Moreover, a solar hot water heater serves as a good introduction, to and illustration of, more sophisticated active solar space heaters, since both are derived from roughly similar engineering concepts.

The loan program would feature an interest rate 'break' for qualified homeowners. The lender's role would be to investigate and perform economic analyses on specific systems to be financed; the mortgage decision itself, in addition to conventional considerations of applicant eligibility, would be based on the results of a thorough Life Cycle Cost evaluation of each system.

Thus the program would be an experiment to test: 1) the effectiveness of Life Cycle Costing as a method of system evaluation for lending purposes; 2) the strength of consumer interest in alternate energy, measurable in loan demand; and 3) interest on the part of the general banking community in involvement in alternate energy financing, measurable in third-party banker attention to the program.

The experiment would be an opportunity to refine and simplify both economic and technical evaluation methods used by Maine Audubon. Well developed methods that are also simple enough to apply will inevitably

attract the interest of other bankers in the field. By far the greatest advantage of the program (depending, of course, on additional loan demand actually induced) would be the actual on-site experience with solar components gained by the consumers who install solar hot water systems in their homes. Heightened awareness of "the solar idea" would inevitably rub off on the purchasing public.

Implementation of an aggressive lending program will of necessity vary across the country depending on banking laws (unit or branching etc.), dominance of one particular institution, geographic location, and relative sophistication of the lender. As an example, Florida bankers have routinely loaned against solar hot water heaters for a number of years but the concept is unfamiliar to many bankers in the northern states. The important point is that there can and should be a system devised to monitor results of active entrance into the field of solar energy. Whether it be through trade associations such as the American Bankers Association or Robert Morris Associates, through consortium participation with utility companies, equipment manufacturers and engineering groups, or by some other means, the benefits and pitfalls must be evaluated and made widely available to the banking industry. In the final analysis, solar technology is conceptually no different than the automobile or computer industries in their developmental stages through to maturation. The banking industry played a vital role in developing highly refined and sophisticated techniques which are universally accepted. The same will be true of solar energy in its refinements; the time to start is now.